The deterioration of US water distribution infrastructure is reaching a critical stage. Upgrades must be conducted rapidly to avoid catastrophic public health and financial risks. Trenchless pipe repair techniques can be part of an infrastructure rehabilitation solution. **BY DON TALEND**

**TRENCHLESS PIPE REPAIR**

**TAMING CAPITAL IMPROVEMENT CHALLENGES**

**MORE THAN 1 MILLION MILES** of pipe in the United States is nearing the end of its useful life and must be replaced soon. In areas where shifting populations necessitate capacity expansion, the need is even more urgent. AWWA’s 2012 report, *Buried No Longer: Confronting America’s Water Infrastructure Challenge*, details the problems and challenges.

The estimated cost of restoring and expanding water distribution systems to maintain current US service levels is at least $1 trillion during the next 25 years. Water distribution networks built in the late 19th and early to mid-20th centuries will soon need to be replaced at an unprecedented scale. Trenchless methods of rehabilitation, such as pipe bursting, can provide quick results and minimize costs.

However, capital investment is only half of a financial equation. In construction, time truly is money. Open-cut pipe installation and replacement is often cost-prohibitive because of the time required and unacceptable service disruptions, as well as the high cost of subsequent backfill and road, sidewalk, and landscape replacement. Trenchless repair techniques are used increasingly because they significantly reduce time, costs, and inconvenience.

Such rehabilitation techniques also allow utilities to stretch their budgets, install and replace systems before catastrophes occur (in some cases), and conduct repairs before the work becomes more expensive and disruptive. Aside from financial benefits, however, trenchless techniques result in minimal disruptions to traffic and customers, minor impacts to installation or repair areas, and vastly improved flow and water quality.
A typical pipe-bursting sequence includes a variety of repair equipment and activities, including (1) a pull head attached to PVC replacement pipe, shown next to a gray expander head; (2) a pipe cutter; (3) the pipe cutter, expander head, and pull head attached to the carrier pipe; (4) the bursting assembly in a pull-in trench, ready to burst the host pipe; (5) a fusible PVC pipe string in the street and curving into the pull-in trench with unimpeded traffic; (6) the expander head and pull head bursting host pipe; (7) bursting through a cast-iron coupling; (8) the opposite end of the burst alignment with bursting machine in the pull pit; and (9) patched asphalt where the pull pit had been located.
TRENCHLESS METHODS
Two trenchless rehabilitation techniques are commonly used.

Slip lining. This method, which involves installing a new carrier pipe within an existing host pipe, is relatively easy and doesn’t require specialized equipment. Slip lined pipe, however, may reduce the flow area within a line because of the size difference between the inside diameter of the existing pipe and the outside diameter of the new pipe.

Pipe bursting. In contrast, pipe bursting uses specialized machines that use pneumatic, hydraulic expansion or static pull systems to pull new carrier pipe through the center of existing (host) pipe, simultaneously splitting the host pipe and displacing the pipe fragments into the surrounding soil. During this process, an “expander head” is often used to widen the pathway for the new pipe being pulled in, thus allowing “upsized” pipe to be installed in the original space. This option allows new pipe with a diameter larger than the original host pipe’s to be installed without disrupting adjacent utilities.

WIDESPREAD USE
Trenchless pipe replacement techniques already play a significant role in water system rehabilitation initiatives. According to a February 2012 Underground Construction magazine survey, 24.1 percent of municipal officials report that trenchless construction and rehabilitation methods have highly affected their operations, and 39.1 percent report a moderate impact.

Survey respondents, who indicated that the condition of their water systems had become critical in many areas because of funding delays resulting from the recent economic downturn, report that capital funding is increasing, although not at a sufficient level to address a crisis. Respondents have increased overall 2011 spending for construction of new underground infrastructure piping 1.3 percent (to $7.8 billion) for 2012. A more aggressive 3.5 percent increase ($5.7 billion) is deemed necessary to fund rehabilitation.

UTILITY EXPERIENCES
In focusing on pipe bursting specifically, several recent projects demonstrate that trenchless techniques allow utilities of all sizes to outsource projects or manage the projects themselves. Different approaches were used, but the utilities all enjoyed significant cost savings.

Lakewood, Colo. Consolidated Mutual Water provides water to about 22,000 customers (about 90,000 people) in the greater Denver Metropolitan area. In 2010, after conducting and evaluating a small-scale experiment, the utility embarked on a large-scale pipe bursting program. The utility initially enlisted the help of a contractor that used the same equipment and methods for a similar project in the Kansas City, Mo., area.

Consolidated Mutual Water replaced about 23,000 linear ft of water main in an undersized and antiquated portion of the distribution network with fused polyvinyl chloride (FPVC) pipe under a rolling schedule. The project was deemed a huge success, with minimal traffic and customer disruptions, minimal impact to installation areas after pipe replacement, improved flow and water quality, and savings of more than $1 million compared with the costs of open-cut replacement.

Table 1. 2010 Projected Pipe Replacement Costs, Consolidated Mutual Water
Estimated cost savings came in two major areas: the reduced cost of asphalt resurfacing and reduced installation and labor costs.

<table>
<thead>
<tr>
<th></th>
<th>Orchard Road</th>
<th>26th Place</th>
<th>33rd Avenue</th>
<th>32nd and Tabor</th>
<th>Weighted Average</th>
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<tr>
<td>Pipe length (ft)</td>
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<td>542</td>
<td>2,213</td>
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<td>Diameter (in.)</td>
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<td>Labor/overhead</td>
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<td>Road-cut repair</td>
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<td>Total</td>
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<td>$224,710</td>
<td>$69,810</td>
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<tr>
<td>Total/linear ft</td>
<td>$90.58</td>
<td>$115.77</td>
<td>$101.54</td>
<td>$98.32</td>
<td>$100.03</td>
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Table 2. Actual Pipe-Bursting Costs, Consolidated Mutual Water
Pipe bursting enabled replacement pipe to be installed in less than half the time, required less surface rehabilitation, and saved the utility about $1.3 million.

<table>
<thead>
<tr>
<th></th>
<th>Allison Street</th>
<th>Brentwood Street</th>
<th>West 4th Avenue</th>
<th>West 1st Place</th>
<th>Weighted Average</th>
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<tbody>
<tr>
<td>Pipe length (ft)</td>
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<td>2,800</td>
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<tr>
<td>Diameter (in.)</td>
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<td>6</td>
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<tr>
<td>Labor/overhead</td>
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<td>$22.49</td>
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<tr>
<td>Road-cut repair</td>
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<td>$3,830</td>
<td>$12,420</td>
<td>$3,830</td>
<td>$3.82</td>
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<tr>
<td>Total</td>
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<td>$59,860</td>
<td>$143,510</td>
<td>$52,160</td>
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<tr>
<td>Total/linear ft</td>
<td>$50.72</td>
<td>$45.35</td>
<td>$51.25</td>
<td>$62.10</td>
<td>$51.37</td>
</tr>
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</table>

Innovation and experimentation with trenchless techniques such as pipe bursting will help North American utilities address the looming $1 trillion underground infrastructure challenge.

Consolidated Mutual Water's original budget for an open-cut replacement program was about $2.4 million based on historic data regarding labor, time, and equipment needs for 6-in. pipe replacement. The costs were correlated with expected rate structures for the 2010 time period (Table 1). It was estimated that cost savings would come in two major areas:

- Reduced cost of asphalt resurfacing
- Reduced installation and labor time

Consolidated Mutual Water's staff determined that replacement pipe could be installed in less than half the time required by an open-cut pipe replacement, would require significantly less surface rehabilitation, and save the utility about $1.3 million (Table 2). Pipe bursting reduced the utility's costs by about 50 percent and reduced construction hassles and surface restoration. Cost savings of 20–50 percent have proved to be typical for additional work since 2010. By using its own crews, the utility controlled the schedule to achieve high levels of productivity (Table 3).

Denver. Serving 1.3 million customers, Denver Water undertook pipe bursting rehabilitation programs in 2011 and 2012. In 2011, when Denver Water replaced nearly 4,000 ft of 6- and 8-in. cast-iron water mains, the utility saved an average of $32/linear ft, according to Jim Olson, Denver Water’s materials coordinator. In the 2011 project phase, Denver Water paid a contractor for most of the work and saved $120,000.

Denver Water managers note that pipe bursting offers significant advantages in busy residential areas. Residents don’t lose access to their homes, water service is interrupted for only 1–2 hours, road repairs are limited to small patches, and unsightly project spoils are greatly reduced.

“In 2012, we expect to save even more by being trained to fuse FPVC pipe and by utilizing our own crews and heavy equipment,” Olson said. So far in 2012, Denver Water has installed about 8,000 ft of FPVC pipe via pipe bursting.

Brownwood, Texas. Since 2007, David Harris, utilities director of Brownwood, Texas, has used pipe bursting to replace 50 6-in. vitreous clay tile (VCT) sewer mains with spline-locked restrained joint PVC (RJPVC) pipe. The city’s 148-mile-long sewer collection system was experiencing root intrusions, cracks, offset joints, collapsed mains, hammer taps, and grease. The cost of open-cut replacement was estimated to be $40/ft; pipe bursting the 6-in. VCT with 8-in. RJPVC cost the utility $25/ft.

Pipe bursting with RJPVC offered several advantages, including the ability to use PVC. The mechanically joined product demonstrated higher efficiency in tight easements, according to Harris. The lessons learned by the city include the fact that RJPVC is installed more efficiently and can be used in a wider range of applications than high-density polyethylene plastic pipe; video inspections are required; a flat, firm pulling surface for the bursting machine is necessary; and correct placement of bursting equipment makes pulling more efficient and safe.

A GAME CHANGER

Pipe bursting is a game-changing, cost-effective technique for large and small water utilities facing daunting capital improvement challenges. Flexibility in project management, pipe materials, outsourcing or insourcing, and support from technology providers allow utilities to “test drive” the technique for themselves with little risk.

Innovation and experimentation with trenchless techniques such as pipe bursting will help North American utilities address the looming $1 trillion underground infrastructure challenge.